Testimony

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Thank you, Senator McCain, for this opportunity to address the Committee on Commerce, Science, and Transportation. My name is James J. McCarthy, and I am a Professor of Oceanography, the Director of the Museum of Comparative Zoology, and the Head Tutor for undergraduate students studying Environmental Science and Public Policy at Harvard University.

For nearly four years I have co-chaired Working Group II (WG II) of the Intergovernmental Panel on Climate Change (IPCC). The focus of this working group has been to assess potential impacts, adaptations, and vulnerabilities to climate change. In my letter of invitation to this hearing you have asked that I comment on the results and conclusions of the IPCC WG II and other related issues that I wish to bring to the attention of the Committee.

The new WG II report, *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, is the most comprehensive and up-to-date scientific assessment of the consequences of, and adaptation responses to, climate change. The report:

- evaluates evidence that recent observed changes in climate have already affected a variety of physical and biological systems.
- makes a detailed study of the vulnerabilities of human populations to future climate change, including associated sea-level rise and changes in the frequency and intensity of climate extremes such as floods, droughts, heat waves and windstorms, and taking into account potential impacts on water resources, agriculture and food security, human health, coastal and other types of settlements, and economic activities.
- assesses the potential responses of natural environments and the wildlife that inhabit them to future climate change and identifies environments at particular risk.
- considers how adaptation to climate change might lessen adverse impacts or enhance beneficial impacts.
- provides an overview of the vulnerabilities and adaptation possibilities by major region of the world (Africa, Asia, Australia/New Zealand, Europe, Latin America, Polar Regions, and Small Island States).
- contrasts the different vulnerabilities of the developed and developing parts of the world and explores the implications for sustainable development and equity concerns.

Research on climate impacts has grown considerably during the five years since the last IPCC assessment, and much has been learned regarding the potential risk of damage associated with projected climate change. In particular, this research has added new understanding of vulnerabilities to climate change across a spectrum of ecological systems (forests, grasslands, wetlands, rivers, lakes and marine environments) and human systems (agriculture, water resources, coastal resources, human health, financial institutions, and human settlements).

Observational evidence of changes has accumulated in many physical and biological systems (*e.g.* glacial melting, shifts in geographic ranges of plant and animal species, and changes in plant and animal biology) that are highly consistent with warming observed in recent decades. These observations are adding to our knowledge of the sensitivity of affected systems to changes in climate and can help us to understand the vulnerability of systems to the greater and more rapid climate changes projected for the 21st century. A number of unique systems are increasingly recognized as especially vulnerable to climate change (*e.g.* glaciers, coral reefs and atolls, mangroves, boreal and tropical forests, polar and alpine ecosystems, prairie wetlands, and remnant native grasslands). In addition, climate change is expected to threaten some species with greater probability of extinction. Potential changes in the frequency, intensity, and persistence of climate extremes (e.g. heat waves, heavy precipitation, and drought) and in climate variability (e.g. El Niño – Southern Oscillation) are emerging as key determinants of future impacts and vulnerability. The many interactions of climate change with other stresses on the environment and human populations, as well as linkages between climate change and sustainable development, are increasingly emphasized in recent research and preliminary insights from these important efforts are reflected in the report.

The value of adaptation measures to diminish the risk of damage from future climate change, and from present climate variability, was recognized in previous assessments and is confirmed and expanded upon in the new assessment. Understanding of the determinants of adaptive capacity has advanced and confirms the conclusion that developing countries, particularly the least developed countries, have lesser capacity to adapt than do developed countries. This condition results in relatively high vulnerability to damaging effects of climate change in these countries.

More Specific New Findings

The effects of recent climate change are now clearly evident in many natural systems. Changes in the distribution of species as documented in the fossil record have long been used as an important diagnostic of past climate. In addition, it is well known that the seasonal behavior of many species, such as migrations and reproductive behavior (e.g. flowering time and egg laying) are sensitive to temperature. In the past few decades substantial changes in these characteristics have been noted for many species, and for 80% of the cases for which such changes could plausibly be linked to temperature, the biotic changes were consistent with changes in regional temperature.

The documented changes in Arctic sea ice cover, both its thinning and its shrinkage during summer, affect polar ecosystems. The shrinkage that is occurring has averaged 3% per decade for the entire Arctic over the last three decades. Throughout Northern Hemisphere freshwater ecosystems the ice-free season is now nearly 2 weeks longer than it was a century ago, which is consistent with an average annual temperature increase of about 1°C. Increased access for ships is a positive aspect of this trend. During the summer of 2000, for the first time in recorded history, a RCMP ship transited the Northwest Passage without touching ice. With summer ice-free conditions in the Arctic expanding poleward, ecosystems will shift accordingly. Marine mammals, such as walrus, certain seals, and the polar bear have evolved with a dependence on ice for successful feeding and rearing of their young. As summer ice retreats from land earlier in the season and reaches greater maximum distances, the success of these species will be challenged. Now, in the span of a single human generation, observations point to a coherent shift in the pattern of temperature sensitive systems on all continents.

Many human systems are also inherently sensitive to climate change. Examples in the IPCC report include:

- changes in potential crop yields, especially reductions in most tropical and subtropical regions.
- changes in water availability, especially losses in the sub-tropics.
- an increase in the number of people exposed to vector born diseases like malaria and water borne diseases like cholera.
- increased losses of lives, livelihood, and property from heavy rains and sea level rise.

Already the increased frequency and intensity of extreme precipitation events has taken a heavy toll. Devastation caused by floods and mudslides in tropical to temperate regions on all continents in the last decade has been without precedent. While a gradual increase in temperature might be accommodated by many natural and human systems, the projected increases in frequency, intensity, and persistence of extreme events has the potential to be enormously disruptive. Moreover the impacts of these changes will fall disproportionately on the poorest peoples. While this may be an obvious conclusion when comparing certain developed and developing countries, it will also be true within a developed country. The fraction of the population that is vulnerable to an extreme heat wave or flood will increase with the severity of the extreme event.

Many of the most devastating aspects of climate change will occur in tropical and subtropical regions, where 70% of the world's population live, many in developing countries. These are the regions that will be the most water stressed, suffer the greatest potential losses of agricultural capacity, and be most vulnerable to the expanded ranges of certain infectious diseases. Even allowing for possible benefits from climate change in some temperate regions, such as net gains in potential crop yields, the negative aspects of climate change in subtropical and tropical regions are likely to offset these positive aspects even assuming there would be no infrastructure or financial obstacle to the distribution of resources, i.e. food, moved from one region to another.

Thus the following are evident in the recent IPCC assessment:

- responses to climate change are already occurring in natural and human systems.
- it is highly likely that climate changes in the 21st century will be 2 - 10 faster than those of the 19th century.
- increased frequency and severity of extreme events will be costly to natural and human systems.

Given the inertia in human system-climate system linkages, these findings lead inevitably to the conclusion that even the most optimistic scenarios for mitigating future climate change are unlikely to prevent significant damage from occurring. This is not to say that mitigation efforts such as a fully implemented Kyoto Protocol won't be effective; rather that their effect won't be evident for decades. Thus, an important finding of the IPCC is that adaptation will be absolutely necessary to minimize damage that is projected

from future climate change. Limitations in adaptive capacity will make some regions and some peoples of lesser means more vulnerable to the impacts of climate change. Natural systems will be affected in all regions from polar to tropical on all continents. Human systems will, however, be most vulnerable to climate change in Africa, Latin America, and Asia where current adaptive capacity is low.

If we wish to minimize the loss of lives, livelihoods and property that will occur during our inevitable transition to a warmer world, it is imperative that we redouble efforts to both minimize the emissions of fossil fuel combustion products and prepare peoples and systems as best we can for the disruption that will ensue with the climate change that is now projected for the 21st century.

Comments on the IPCC Process

Nowhere can one find a process that produces a report on the understanding of a broad area of science that is more inclusive in its coverage of contemporary scientific views, or more broadly vetted by the scholarly community than with the IPCC. The basis of the assessment is the peer-reviewed published scientific literature. Every effort is made to be thorough, and serious attention is given to disparate results and conclusions in this literature. To the extent possible, degrees of likelihood are assigned to summary statements, especially those on projected climate conditions and climate impacts.

Currently about 100 governments participate in the IPCC, and all were invited to propose the names of experts who could serve as authors of this report. More than one thousand nominations were received for WG II authors, with supporting documentation listing the nominees' publications in scientific journals. It should be noted that the authors of IPCC reports work without financial compensation for their efforts on behalf of the IPCC.

The report of WG II was drafted between July 1998 and February 2001 by 183 Lead Authors. In addition, 243 Contributing Authors, from nearly 70 countries, submitted draft text and information to the Lead Authors. Drafts of the report were circulated twice for review, first to experts and a second time to both experts and governments. Comments received from 440 reviewers were carefully analyzed and assimilated in a revised the document, with guidance provided by 33 Review Editors. The full report

was then condensed into a 70-page manuscript, known as a Technical Summary (TS), and it was then further condensed into a 20-page manuscript known as a Summary for Policy Makers (SPM). The TS and SPM (along with a revision of the full report that reflected the earlier government and expert review) were then sent out for a final review coordinated by governments.

Comments from this final review were then used to prepare a revision of the SPM and TS, and a plenary of the Working Group was convened to consider final approval of the SPM. This involved about 150 delegates from 100 nations, drawn from each nation's departments and ministries of state and science. The plenary met for four days in Geneva (Switzerland) in February 2001 to vet the SPM line-by-line, proceeding to the next line only when all delegates agreed to do so.

While the science that underpins SPM was clear to its authors as their document was taken to the plenary for approval, the plenary is actually the final stage in this process of clarifying the message for policy makers. Discussions in the course of the plenary called attention to words and sentences that were perceived to be unclear by a delegate, and suggested changes were made as long as they were not inconsistent with the underlying science. By the conclusion of the meeting the Summary for Policymakers was approved in detail and the full report accepted by all delegations.

The Working Group Summary for Policy Makers is attached. It and related documents are available in pdf format at www.usgcrp.gov/ipcc